

Homework 3 (due Feb 4)

1. Consider the simple model of a linac for particles of mass m and charge q . The hollow cylindrical electrodes have lengths L_1, L_2, L_3 etc. and are separated by thin gaps of negligible width. The potential difference across the gap between two consecutive electrodes is represented by a square wave of period T , frequency $f = 1/T$, peak-to-peak amplitude $2V$, and zero average value. The voltage between electrodes 3 and 2 is 180° out of phase with respect to the voltage between electrodes 2 and 1, and so on.

The particles have initial kinetic energy K_0 , $K_1 = K_0 + qV$ inside electrode 1, $K_2 = K_0 + 2qV$ inside electrode 2, and so on.

- (a) Under the conditions of resonant acceleration, find the length L_n of the n th electrode as a function of K_0 , V , f , and the properties of the particle, m and q .
 - (b) Choose reasonable values for L , K_0 and V and estimate the operating frequency f for a Na^+ ion linac and for an electron linac.
2. A proton cyclotron has radius $R = 50$ cm and magnetic field $B = 1.5$ T.
 - (a) Calculate the cyclotron frequency.
 - (b) Find the maximum kinetic energy.
 - (c) Comment on whether relativistic effects are important for this machine.